Programme Name/s : **Chemical Engineering**
Programme Code : **CH**
Semester : **Third**
Course Title : **CHEMICAL PROCESS TECHNOLOGY**
Course Code : **313337**

I. RATIONALE

The Chemical Process Technology course is designed with an objective to select raw materials, chemical reaction, manufacturing processes of chemicals and also develop an ability to comprehend various unit operations carried out in chemical industry.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The course should be taught and implemented with the aim to develop required skills in students so that they are able to acquire following industry outcome:
Chemical engineering student will be able to select appropriate chemical manufacturing process for the given application.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Identify manufacturing process for acid and alkali from given raw material.
- CO2 - Select fertilizer manufacturing process for given application.
- CO3 - Identify manufacturing process for oil and soap from given raw material.
- CO4 - Select manufacturing process of polymer from given monomer.
- CO5 - Identify various alcohol and phenol manufacturing methods for given application.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
313337	CHEMICAL PROCESS TECHNOLOGY	CPT	DSC	3	-	4	1	8	4	03	30	70	100	40	25	10	25#	10	25	10	175

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Select raw materials for the manufacturing process. TLO 1.2 Optimize reaction parameters. TLO 1.3 Draw process flow diagram for manufacturing process. TLO 1.4 Explain process flow diagram for manufacturing process. TLO 1.5 Explain properties and applications of acids and alkalis	**Unit - I Manufacturing of Acid and Alkali** 1.1 Raw materials, chemical reaction, process description with flow diagram for manufacturing of hydrochloric acid. 1.2 Raw materials, chemical reaction, process description with flow diagram for manufacturing of sulphuric acid. Comparison between vanadium pentaoxide and platinum catalyst. 1.3 Raw materials, chemical reaction, process description with flow diagram for manufacturing of sodium hydroxide. 1.4 Raw materials, chemical reaction, process description with flow diagram for manufacturing of sodium carbonate by Solvay's process. 1.5 Properties and uses of hydrochloric acid, sulphuric acid, sodium hydroxide and sodium carbonate.	Lecture Using Chalk-Board Presentations Video Demonstrations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Identify different types of fertilizers. TLO 2.2 Draw process flow diagram for manufacturing process. TLO 2.3 Select the appropriate type of fertilizer for given application. TLO 2.4 Explain applications of fertilizer. TLO 2.5 Differentiate between chemical fertilizer and bio fertilizer.	**Unit - II Manufacturing of Fertilizer** 2.1 Classification of fertilizers (Straight, Complex and mixed). 2.2 Raw materials, chemical reaction, process description with flow diagram for manufacturing of urea. 2.3 Raw materials, chemical reaction, process description with flow diagram for manufacturing of single super phosphate and triple super phosphate. 2.4 Raw materials, chemical reaction, process description with flow diagram for manufacturing of Di-ammonium phosphate. 2.5 Mixed fertilizer :Importance of mixed fertilizers. 2.6 Bio fertilizer : Need and importance of bio fertilizers.	Lecture Using Chalk-Board Presentations Site/Industry Visit
3	TLO 3.1 Analyse quality of oil as per given parameters. TLO 3.2 Apply solvent extraction process for improving oil recovery. TLO 3.3 Explain manufacturing of soap. TLO 3.4 Classify soap on the basis of total fatty matter.	**Unit - III Manufacturing of Oil and Soap** 3.1 Classification of oil. Properties of vegetable oil : acid value, saponification value and iodine value (Definition and Significance). 3.2 Process description with flow diagram of oil extraction from oil seed. 3.3 Hydrogenation process of oil. 3.4 Raw materials, chemical reaction, process description with flow diagram for manufacturing of soap by continuous process. 3.5 Classification of soap on the basis of total fatty matter (TFM). Cleansing action of soap.	Lecture Using Chalk-Board Presentations Video Demonstrations
4	TLO 4.1 Explain mechanism of polymerization. TLO 4.2 Select raw materials for the manufacturing process. TLO 4.3 Draw process flow diagram for manufacturing process. TLO 4.4 Explain process flow diagram for manufacturing process. TLO 4.5 Optimize reaction parameters for identified process.	**Unit - IV Manufacturing of Polymer** 4.1 Classification of polymers on the basis of origin, structure, molecular forces and method of preparation. 4.2 Raw materials, chemical reaction, process description with flow diagram for manufacturing of polyethylene by Zeigler process. Types of polyethylene. 4.3 Raw materials, chemical reaction, process description with flow diagram for manufacturing of polyvinyl chloride (PVC). Types of PVC. 4.4 Chemical reaction, process description with flow diagram for manufacturing of polyester from dimethyl terephthalate (DMT) and ethylene glycol (EG). 4.5 Uses of polyethylene, PVC and polyester.	Lecture Using Chalk-Board Demonstration Video Demonstrations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Select raw materials for the manufacturing process. TLO 5.2 Draw process flow diagram for manufacturing process. TLO 5.3 Explain process flow diagram for manufacturing process. TLO 5.4 Optimize reaction parameters for identified process. TLO 5.5 Explain properties and applications of alcohol and phenol.	**Unit - V Manufacturing of Alcohol and Phenol** 5.1 Introduction of fermentation, Types of fermentation. 5.2 Raw materials, chemical reaction, process description with flow diagram for manufacturing of ethanol from molasses. 5.3 Raw materials, chemical reaction, process description with flow diagram for manufacturing of ethyl acetate. 5.4 Raw materials, chemical reaction, process description with flow diagram for manufacturing of phenol by cumene process. 5.5 Raw materials, chemical reaction, process description with flow diagram for manufacturing of phenol by Raschig process. 5.6 Properties and uses of alcohol and phenol.	Lecture Using Chalk-Board Presentations Site/Industry Visit Video Demonstrations

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Titrate the sample against standard solution. LLO 1.2 Calculate strength from obtained normality.	1	* Determine strength of hydrochloric acid by titration.	4	CO1
LLO 2.1 Calculate percentage purity from strength.	2	Determine percentage purity of soda ash by titration.	4	CO1
LLO 3.1 Operate pH meter for analysis. LLO 3.2 Calculate percentage purity from strength.	3	Determine percentage purity of sulphuric acid by using pH meter.	4	CO1
LLO 4.1 Calculate percentage purity from strength. LLO 4.2 Operate pH meter for analysis.	4	* Determine percentage purity of sodium hydroxide by using pH meter.	4	CO1
LLO 5.1 Operate neutralization reaction under controlled conditions.	5	Determine nitrogen content of ammonium chloride.	4	CO2
LLO 6.1 Calculate composition from reaction stoichiometry.	6	Determine nitrogen content of ammonium sulphate.	4	CO2
LLO 7.1 Calculate composition based on nature of sample. (Number of ammonia molecule)	7	* Determine ammonia content of ammonium chloride.	4	CO2
LLO 8.1 Analyse given sample of urea.	8	* Determine percentage purity of urea / nano urea / Diesel Exhaust Fluid (DEF).	4	CO2
LLO 9.1 Identify quality of given oil sample.	9	Determine acid value of vegetable oil.	4	CO3
LLO 10.1 Perform saponification reaction under controlled parameters.	10	Determine saponification value of vegetable oil.	4	CO3
LLO 11.1 Identify quality of given sample soap based on alkali content.	11	* Determine total alkali content in soap sample.	4	CO3
LLO 12.1 Identify grade of given sample of soap.	12	* Determine total fatty matter in soap sample.	4	CO3

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 13.1 Perform condensation polymerization reaction.	13	* Prepare phenol formaldehyde resin.	4	CO4 CO5
LLO 14.1 Verify acid content in polymer sample.	14	Determine acid value of polymer sample.	4	CO3 CO4
LLO 15.1 Calculate acid value of phenol.	15	Determine acid value of phenol.	4	CO3 CO5
LLO 16.1 Perform esterification reaction in controlled manner.	16	* Prepare ethyl acetate from alcohol and acetic acid.	4	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment

- Explore fertilizer manufacturing industries in Maharashtra and prepare list with address and contact details.
- Explore chemical manufacturing industries in Maharashtra and prepare list with address and contact details.
- Prepare a list of chemical products used in daily life, their typical application and chemical composition.
- Use online crossword making tool and prepare crossword on identified topic in a curriculum.
- Prepare a list of raw materials required in manufacturing of fertilizers, their typical application and chemical composition.

Micro project

- Analyze petrol to determine percentage of ethanol content.
- Visit medical store in your area and prepare list of products containing alcohol as a constituent.
- Collect different types of vegetable oil and prepare a report on it's acid value and saponification value.
- Collect different types of toilet soaps and prepare presentation on it's total fatty matter (TFM) content.
- Visit agrochemical shop in your area and prepare list of fertilizers used in farming activity.
- Take interview of farmer and write report based on fertilizers used with quantity.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Water condenser : 300 mm long	10,16
2	Hot air oven : 90 Lit, 50 - 250 Degree Celsius	12,13
3	pH meter with Calibration arrangement Suitable for 0-14 pH range and Temperature compensating and calibration arrangement.	3,4
4	Heating mantle : 500 ml, 300 Watt	5,6,7,8,10,16
5	Weighing Balance : Digital Display, 300 g, Sensitivity. 0.01 g	All
6	Others (apron, safety goggles, acid and alkali proof gloves and shoes)	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Manufacturing of Acid and Alkali	CO1	8	2	6	4	12
2	II	Manufacturing of Fertilizer	CO2	10	4	8	4	16
3	III	Manufacturing of Oil and Soap	CO3	8	2	6	4	12
4	IV	Manufacturing of Polymer	CO4	9	4	6	4	14
5	V	Manufacturing of Alcohol and Phenol	CO5	10	4	8	4	16
Grand Total				**45**	**16**	**34**	**20**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Each practical will be assessed considering - 60 % weightage to process, 40 % weightage to product

Summative Assessment (Assessment of Learning)

- End of term examination, Lab performance, Viva-Voce

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	1	1	1	1	1	2			
CO2	3	-	1	-	2	1	2			
CO3	3	1	1	2	2	1	2			
CO4	3	-	1	-	1	1	2			

CO5	3	-	-	-	1	1	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	M. Gopala Rao and Marshall Sittig	Dryden's Outlines of Chemical Technology - For 21st Century	East-West Press (Pvt.) Ltd., ISBN-10: 9788185938790
2	George T. Austin	Shreve's Chemical Process Industries	Tata McGraw Hill Edition, ISBN-13: 9780070571471
3	P. H. Groggins	Unit Processes in Organic Synthesis	McGraw Hill Education (India) Private Limited, ISBN-13: 9780070852679

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://archive.nptel.ac.in/courses/103/106/103106108/	NPTEL Course : Heavy and Fine Chemicals
2	https://onlinecourses.nptel.ac.in/noc24_ch09/preview	SWAYAM Course : Chemical Process Technology By Prof. Tamal Banerjee, IIT Guwahati
3	https://onlinecourses.nptel.ac.in/noc23_ch46/preview	SWAYAM Course : Organic Chemical Technology By Prof. Nanda Kishore, IIT Guwahati
4	https://www.trp.org.in/wp-content/uploads/2016/11/AJSAT-Vol.2-No.1-Jan-June-2013pp.8-12.pdf	Asian Journal of Science and Applied Technology ISSN 2249 - 0698 Vol. 2 No. 1, 2013, pp.8-12

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students